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## THE MEASUREMENT OF MN AND BR IN MICROSCOPIC ATMOSPHERIC PARTICLES BY THE ACTIVATION METHOD AND THE MEASUREMENT OF MICROSCOPIC DUST PARTICLE DIAMETERS BY THE DIFFUSION METHOD

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(The Measurement of Mn and Br in Microscopic Atmospheric Particles By the Activation Method, and the Measurement of Microscopic Dust Particle Diameters By the Diffusion Method)

[Ryushijo Taiki Osen Busshitsu no Kaisedi (Hoshaka Bunsekiho ni Yoru Kuki Bijinchu no Mn, Br no Sokutei oyobi Kakusan Bunriho ni Yoru Bijio no Ryudei no Sokutei)]

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# ANALYSIS OF PARTICULATE AIR POLLUTANTS

(The Measurement of Mn and Br in Microscopic Atmospheric Particles By the Activation Method,[1] and the Measurement of Microscopic Dust Particle Diameters By the Diffusion Method[2]).

## Summary.

As one of the links in elucidating the mechanics of air pollution, the specified substances, Mn and Br, present in microscopic atmospheric dust was collected at various heights at Tokyo Tower and classified by activation analysis. Measurements were also made of the temporal variations in the particle diameter of microscopic atmospheric dust.

From the analysis of these data:

1. Because Mn demonstrated the same activity as $SO_2$, it is believed that the principal pollution source is the factory group and because Br demonstrates the same action as NO, it is believed that it derives from automotive exhaust gases.

2. From particle diameter measurements, it was determined that 70% of the particles are of 0.01 - 0.05 μm. Represented by weight distribution, however, 20% of the Mn and Br diameters are from 0.5 to 0.8 μm and 80% below 0.5 μm.

## Objectives.

The principal atmospheric pollution in cities is caused by smoke

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emitted from factories and automotive exhaust gas. Analysis of the mechanics of atmospheric pollution first becomes possible when data concerning the type of nuclei in pollutants, concentration, particle diameter and weather conditions, etc., are collected.

Up to the present time, we have used radiation to study the properties and action of acrosols.[3] The present report constitutes one link in the elucidation of air pollution mechanics. The extremely sensitive activation analysis method was used for classifying the specified substances (Mn, V, Na, Br, Cl and Sb) in microscopic atmospheric particles. Concurrently with this, the particle diameters of microscopic atmospheric dust with diameters below 1 μm, which are said to have a major effect on the human body, were measured by the diffusion method and with a Porac [Tr. Note: Phonetic in the original] counter. As some insight concerning the mechanics of air pollution was gained from these results, it is reported below.

## Methods.

1. Activation Analysis: Filter paper is used to collect particulate matter. Because the content of the substances to be measured is low, however, high collection efficiency is demanded. Millipore filter paper, which satisfies this condition, was used in the present tests. The measurements were made at three points on Tokyo Tower at 5 m, 25 m and 127 m above the ground. Samples were collected day and night during two-hour sampling periods. The collected samples were irradiated in the Tokyo Atomic Power Industries HTR No. 1 pneumatic tube ($7.8 \times 10^{11}$ n:$CM^{2} \cdot Sec^{-1}$) for five hours. They were then analyzed with a 30 $cm^{3}$ SSD and a 512 channel wave height analyzer. The short-lived nucleus type were measured 3 - 5 hours after

irradiation and the long-lived nucleus types measured 15 - 20 hours after irradiation.

2. Particle Diameter Measurements: The diffusion box used had 10 stainless steel plates arranged horizontally at intervals of 10 μm. When a laminar flow of air contianing particles is passed through, the particles adhere to the horizontal plates rapidly, beginning with the smallest particles. The quantity of particles adhered is determined with a Porac counter which can measure particles below a size of 0.01 μm ϕ. The average particle diameter is calculated from this.

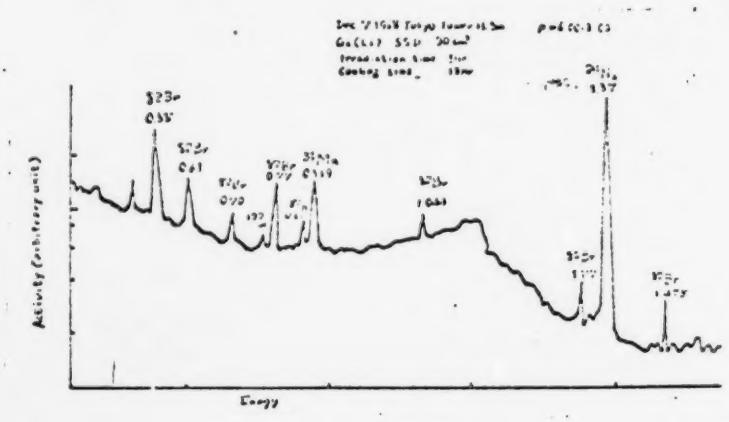

Figure 1. Energy spectrum of -rays in particulate air pollutants irradiated by neutron.

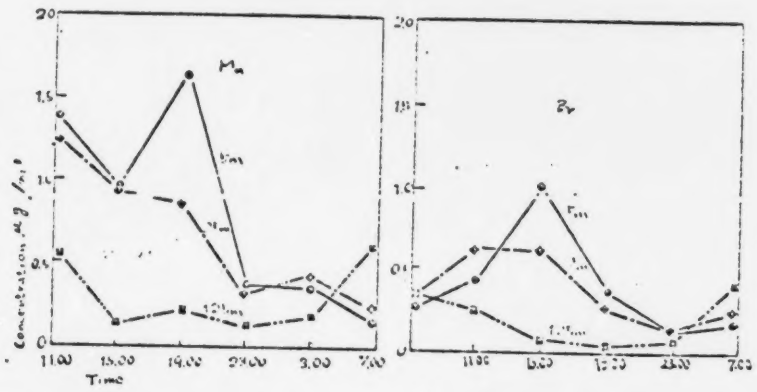

Figure 2. Diurnal variation in concentration of Br and Mn at H:5m, 25m, 127m. (Tokyo Tower Dec. 7-8, 1968.)

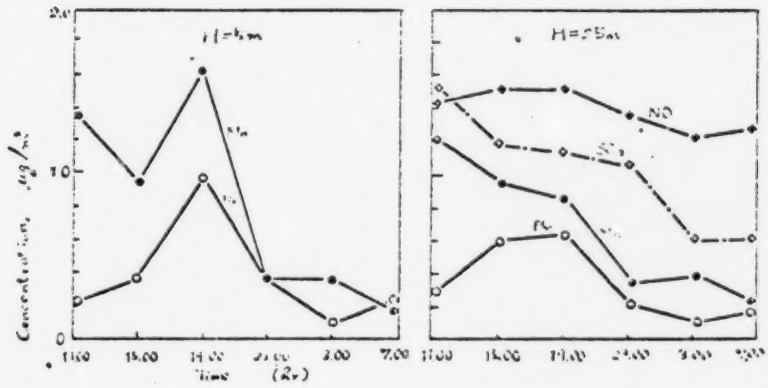

Figure 3. Diurnal variation in concentration of Mn, Br, NO ahd $SO_2$ at H:5m, 25m (Tokyo Tower Dec. 7-8 1968.)

## Results and Discussion

1. Activation Analysis: Fig. 1 shows the spectrum for the samples collected at Tokyo Tower and analyzed. It is possible to identify Na, Br, Mn and Sb, etc. Among these, Mn, which has received particular attention as an atmospheric pollutant, and Br, which is thought to be emitted in automotive exhaust gases, received particular attention and an analysis was made of the patterns of hourly variation.

Fig. 2 shows an example of the measurements made on December 7 and 8, 1968. The patterns for Br and Mn differ, making it evident that the gener-

ation sources are obviously different.

Fig. 3 gives a comparison of the Br and Mn patterns at altitudes of 5 m and 25 m. At 25 m there is a difference between the two substances. The pattern for Mn corresponds well with that of $SO_2$ while that for Br corresponds well with the NO pattern. In addition, Table 1 shows the difference in grain diameter with altitude as measured with a cascade impactor. This shows that the Br particle diameter becomes large at 125 m. From the above, it is believed that the sources of Br and Mn differ and that Mn, like $SO_2$, is principally generated by factories while Br, like NO, is generated by automobiles. Lead in automotive exhaust gas has received particular attention as a toxic substance. It is said it combines with Br and is emitted together with it. Because Br can be detected at high levels of sensitivity, it is expected that highly accurate data concerning the diffusion mechanics of lead, which is difficult to detect by itself, will be obtained.

Table 1. Vertical distribution of particle sizes for Mn and Br at H:25m, 127m (Dec. 7. 14.00 - 16.00 1968, Tokyo Tower.) (by weight)

| ($\mu$m) Diameter | 25 m | | 125 m | |
|---|---|---|---|---|
| | Mn | Br | Mn | Br |
| 0.80~2.0 | 0(%) | 3(%) | 0(%) | 6(%) |
| 0.50~0.80 | 18 | 29 | 38 | 80 |
| ~0.50 | 82 | 68 | 62 | 14 |

Table 2. The Concentration of Mn and Br.

| Site | Element | Concentration | Reference |
|---|---|---|---|
| 1 ハワイ | Br | 0.018 | Dare |
| 2 ワシントン | Mn | 0.0[illegible] | Gordon |
| | Br | 0.22 | 〃 |
| 3 [illegible] | Mn | 0.019 | Yano, Asakuno 5 |
| | Br | 0.028 | 〃 〃 |
| 4 [illegible] | Mn | 0.03 | 〃 〃 |
| | Br | 0.01 | 〃 〃 |

Key:

1 - Hawaii; 2 - Washington; 3 - Sakado Machi (Saitama Prefecture); 4 - Tateno Machi (Ibaraki Prefecture); 5 - Yano, Asakuno.

Table 2 gives some comparisons with other regions. It is evident from this that Tokyo also suffers to a considerable extent from pollution by metals.

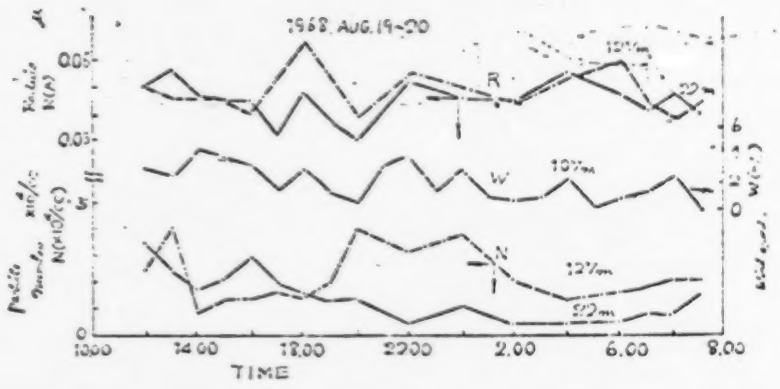


Figure 4. Diurnal variation in concentration and radius of particulate air pollutant at H:22m, 127m. (Aug. 19-20, 1968, Tokyo Tower)

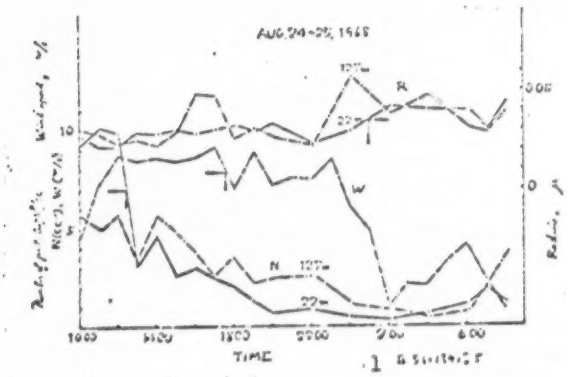


Figure 5. Diurnal variation in concentration and radius particulate air pollutant at H:25m, 127m. (Aug. 24-25, 1968. Tokyo Tower)
Key: 1 - [Illegible].

2. Particle Diameter Measurements: Figs. 4 and 5 give examples of the measurements.

It is evident from these that the particles fall within the -0.05 μm range where the particle diameters are extremely small. Even when one takes into consideration the distribution by number of particles, in the form of the Mn and Br weight distribution, as determined by the cascade impactor method shown in Table 1, it can be postulated that there are great differences in particle diameter as a function of substance. Further, Fig. 6 and Fig. 7 show the correlation between particle diameter (R) and concentration (N) at 25 m and 127 m. This may be represented as

$$25\text{ m } N=KR^{-1.8}$$

$$127\text{ m } N=KR^{-1.5}$$

As the growth and division of atmospheric dust is an extremely complicated process, no definitive statements can be made. However the problem might be thought about in terms of the fact that the number of particles that remain airborne is greater at 127 m and by making a comparison with the

particle diameters at the points where the concentration is low. In addition to the direct effects of atmospheric dust itself on the human body, it is also necessary to know the distribution by particle diameter when one considers its reactions with such gases as $SO_2$, CO, etc.

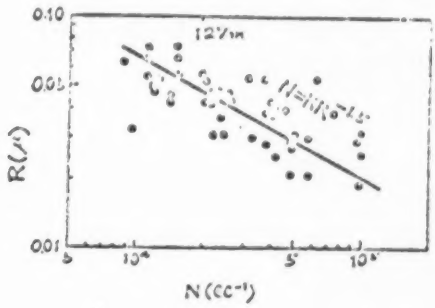


Figure 6. Relation between concentration and radius of particulate air pollutant at H:127m. (Tokyo Tower, Aug., 1968)

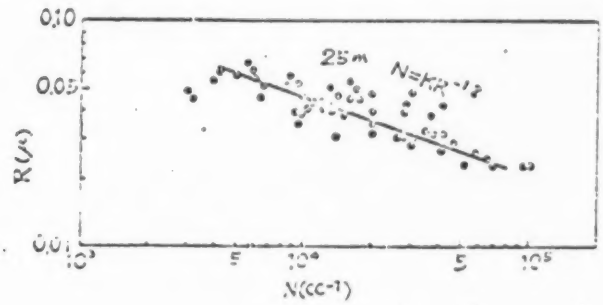


Figure 7. Relation between concentration and radius of particulate air pollutant at H:25m (Tokyo Tower, Aug., 1968)

Results.

The metals in atmospheric pollutants that are present in microscopic quantities are being classified by fluorometric and spectroscopic absorption methods. When these methods are used, it is necessary

to collect great quantities of air in order to obtain test samples and various perparatory treatments are required prior to measurement. These methods are suitable, however, for classifying environmental concentrations such as those which show 24 hour average values. It is necessary to know the variations for periods as short as one hour in order to elucidate the mechanics of pollution. From this viewpoint, the extremely sensitive activation analysis method is superior than the other methods for certain special substances.

In addition, the particle diameter of microscopic atmospheric dust is continuously measured automatically during short periods of time and it is expected that this will play a part in clarifying the hourly variations in microscopic atmospheric dust and in elucidating the mechanisms of air pollution.

Bibliography

(1) Asakuno, Kunihiko, Tokyo Metropolitan Isotope Research Center Annual Report, Vol. 3, 1964, p. 145.

Asakuno, Kunihiko, Shinozaki, Yoshiharu, Ibid, Vol. 4, 1965, p. 61.

Asakuno, Kunihiko, Shinozaki, Yoshiharu, Annual Report of the Tokyo Metropolitan Joint Isotope Research Institute, Fiscal Year 1966, p. 71.

Asakuno, Kunihiko, Shinozaki, Yoshiharu, Ibid, Fiscal Year 1967, p. 46.

Asakuno, Kunihiko, Shinozaki, Yoshiharu, Ibid, Fiscal Year 1967, p. 72.

(2) Note 1. Asakuno, Kunihiko; Yamazaki, Hiroshi; Yamamoto, Tatsuo; Shinozaki, Yoshiharu; Ohira, Toshio: The Ninth National Conference on Air Pollution.

Note 2. Yamazaki, Hiroshi; Asakuno, Kunihiko; Yamamoto, Tatsuo; Shinozaki, Yoshiharu; Ohira, Toshio: The Sixth National Conference On Air Pollution.

Note 3. Asakuno, Kunihiko; Yamazaki, Hiroshi; Shinozaki, Yoshiharu: The Eighth National Conference On Air Pollution.